

IRAS Observations of the PleiadesP. Cox<sup>1</sup> and A. Leene<sup>2</sup>

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Abstract

IRAS observations of the Pleiades region are reported. The data show large flux densities at 12  $\mu\text{m}$  and 25  $\mu\text{m}$ , extended over the optical nebulosity. This strong excess emission, implying temperatures of a few hundred degrees Kelvin, indicates a population of very small grains in the Pleiades. It is suggested that these grains are similar to the small grains needed to explain the surface brightness measurements made in the ultraviolet.

I. Introduction

At a distance of 126 pc, the Pleiades offer a beautiful opportunity to observe the fine structure occurring in interstellar clouds. The well known geometry of the cloud is of great help in characterizing the scattering properties (albedo and phase function) of interstellar dust. The chemistry is unusual in the sense that the column density of  $\text{CH}^+$  is exceptionally high towards the Pleiades cluster. Previous models, based on optical and ultraviolet observations, required that the dust in the Pleiades will be an extended and complex radiation source in the infrared.

We present the IRAS observations of the Pleiades region and give preliminary results of the dust characteristics derived from the infrared data. A paper on this subject is in preparation and will be submitted to *Astronomy and Astrophysics*. Here we give a summary of the salient results.

II. Observational Material and Data Reduction.

The data base consists of IRAS HCON3 scans (IRAS Explanatory Supplement, Ref. 1). The maps were corrected for detector sensitivity effects by two dimensional Fourier filtering. The zodiacal light contribution was estimated by fitting a linear baseline on the entire map and using averaged values derived from a geometrical model of the zodiacal emission (Ref. 2).

The resulting corrected and destriped maps are presented for 12  $\mu\text{m}$  and 100  $\mu\text{m}$  in figures 1 and 2, respectively.

III. Results

The brightness distribution of the infrared emission for the Pleiades is very similar in all four IRAS bands. A ridge of high brightness extends over the western half of the cluster. Three main emission peaks

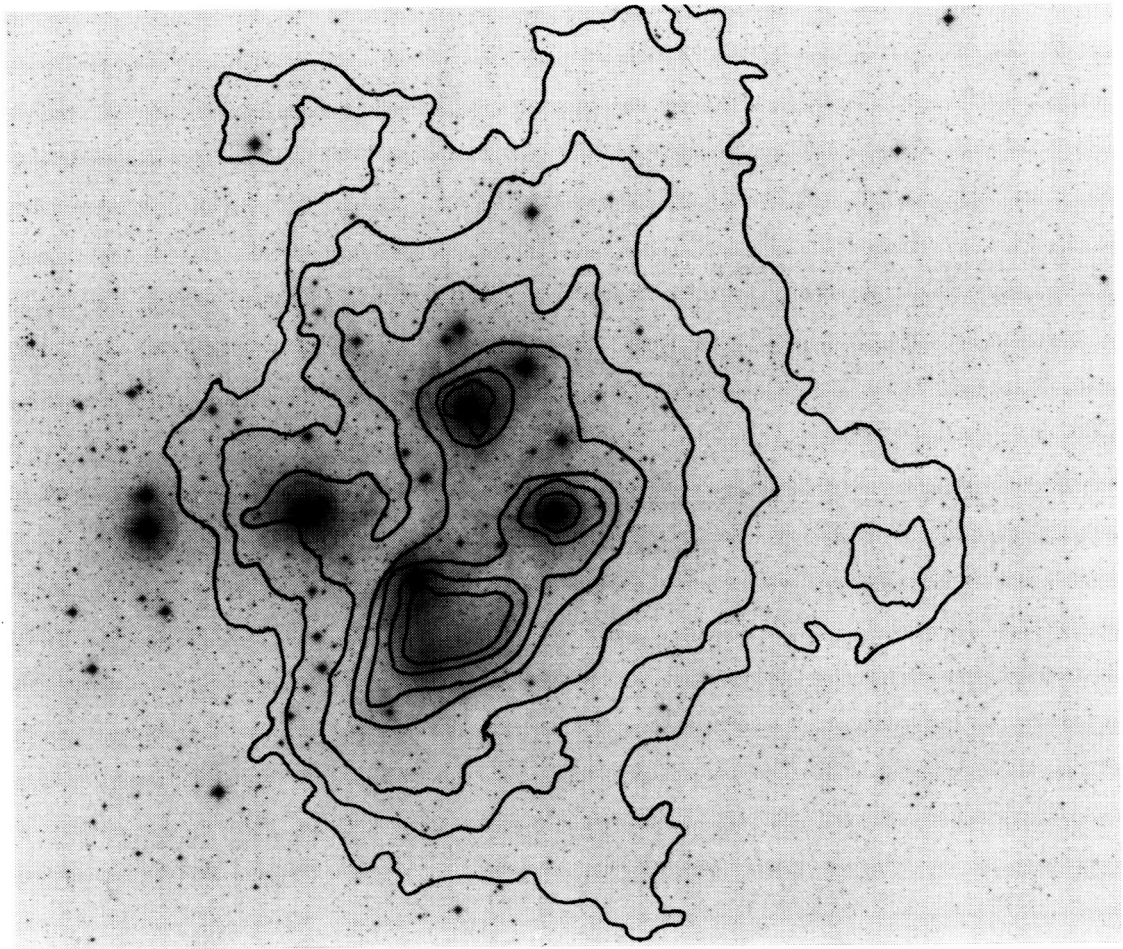


Figure 1: The 12  $\mu\text{m}$  emission map of the Pleiades overlaid on the Red Print of the Palomar Sky Survey.

are apparent, of which the southern is the more intense. A weakening in the infrared distribution is noticeable east of this ridge. A diffuse emission extends from this ridge several degrees across the region.

In figure 1, the 12  $\mu\text{m}$  image is presented superimposed on a copy of the Red Palomar Sky Survey. The brightest infrared component lies south of 23 Tau (Merope) and the two northern peaks correspond to the nebulosities associated with 20 and 17 Tauri.

Figure 2 shows the CO measurements ( $10 \text{ km.s}^{-1}$ ) and the HI emission at  $7 \text{ km.s}^{-1}$  (Ref. 3-4). The CO cloud is slightly shifted with respect to the main infrared peak: note however that the sharp edge of the molecular cloud corresponds with the brightest region of the nebulosity, south of Merope. This feature coincides with a region of obscuration recognizable on visible photographs of the cluster. The HI ridge northern peak corresponds with a decrease in the infrared distribution. No infrared counterpart however is found for the southern HI peak.

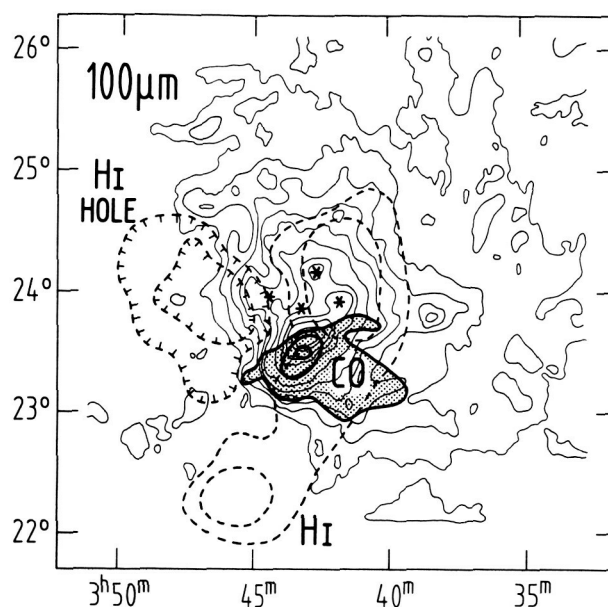


Figure 2: The HI contours ( $7 \text{ km.s}^{-1}$ ) and the CO emission ( $10 \text{ km.s}^{-1}$ ) superimposed on the  $100 \mu\text{m}$  emission map.

In figure 3, the  $12/100 \mu\text{m}$  ratio is presented superimposed on the blue Palomar Sky Survey. The large values of this ratio are striking. The first contour lies at 0.05 and is as extended as the diffuse blue reflection nebulosity.

The  $60/100 \mu\text{m}$  ratio is also very extended and uniform over the nebulosity, indicating temperatures of the order of  $\sim 25\text{K}$ .

#### IV. Discussion

The strong excess emission at  $12 \mu\text{m}$  which is extended over all the region definitely indicates the presence of very small grains ( $\sim 10 \text{ \AA}$  sized) in the Pleiades (Ref. 5). The high values attained by the  $12/100 \mu\text{m}$  ratio suggest that a conspicuous amount of carbon is locked into these grains i. e. up to 10% of the total carbon mass.

The presence of a large population of grains in the  $10 \text{ \AA}$  size has been independently suggested by Witt et al. (Ref. 6) on the basis of ultraviolet measurements. According to these authors the ultraviolet data can only be understood if the scattering phase function becomes more isotropic in the far-ultraviolet, which is a behaviour expected for particles small compared to the wavelength of ultraviolet light. These particles are reminiscent of the free radicals (or 'Platt particles') as described by Andriesse and de Vries (Ref. 7), which have a high albedo in the far-ultraviolet and isotropic scattering i.e.  $g \sim 0.2$ .

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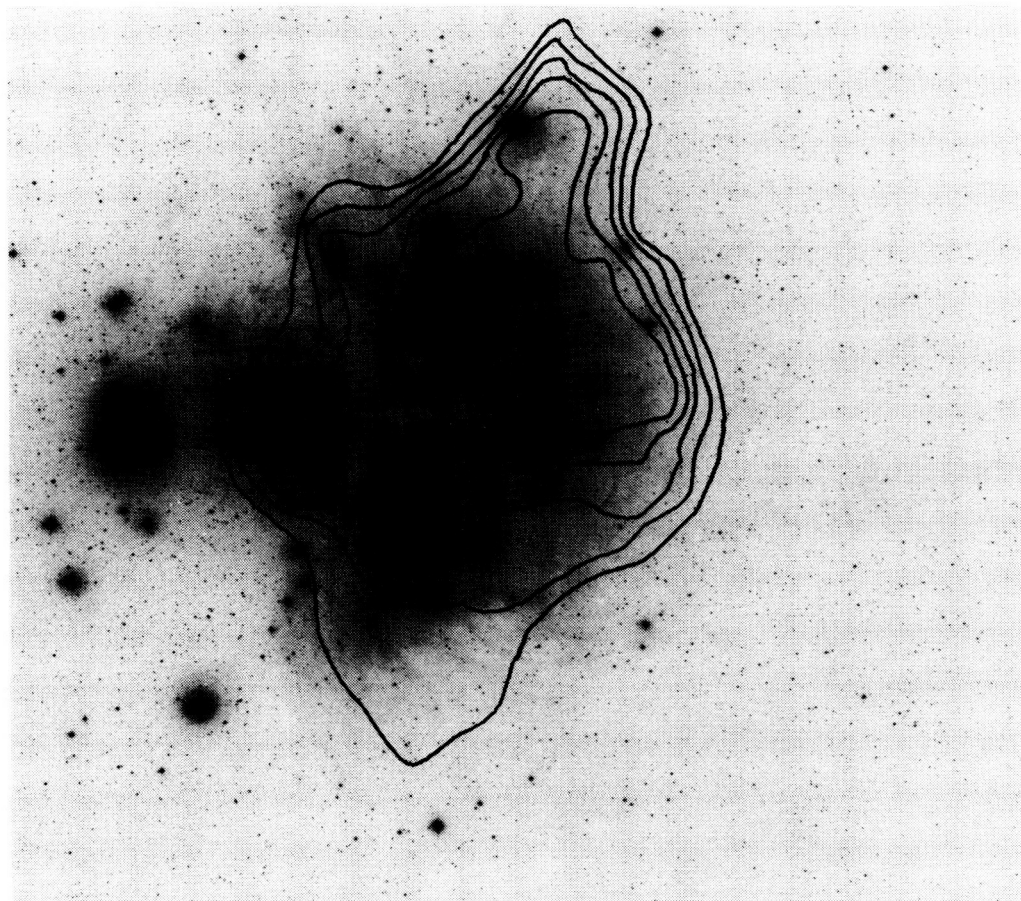


Figure 3: The 12/100  $\mu\text{m}$  ratio overlayed on the blue print of the PSS. Contours are at 0.05 to 0.09 with steps of 0.01.

## V. Conclusions

IRAS observations of the Pleiades are presented. The observations reveal a large flux density at 12  $\mu\text{m}$  and 25  $\mu\text{m}$ , extended over the optical nebulosity, implying temperatures of a few hundred degrees Kelvin. The 60  $\mu\text{m}$  and the 100  $\mu\text{m}$  fluxes give temperatures of the order of 25 K.

The strong excess emission at 12  $\mu\text{m}$  can only be understood in terms of a large population of very small grains (in the 10  $\text{\AA}$  size range). We suggest that these grains are similar to the small grains needed to account for the ultraviolet measurements made on the Pleiades, i. e. isotropic ( $g \sim 0.2$ ) scatterers in the far-ultraviolet. Finally, we note that the unusually high column density of  $\text{CH}^+$  towards the Pleiades (Ref. 8) may perhaps be the key to the origin of these small graphitic particles.

References

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